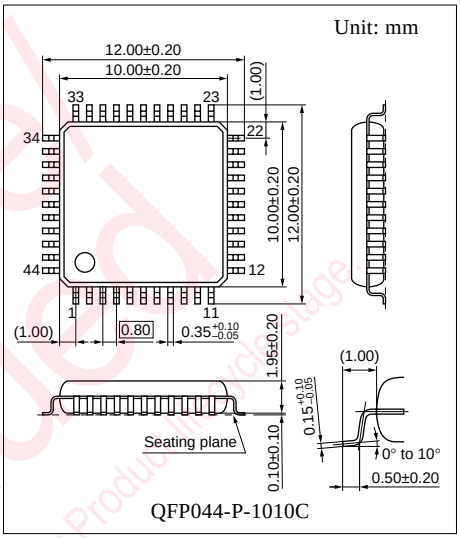
AN8789FB

4-channel driver IC for portable CD/MD player

■ Overview

The AN8789FB is a low power consumption H-bridge system 4-channel driver with a switching regulator incorporating DC-DC converter which allows for low supply voltage operation. It is especially suited for a portable CD/MD player.



QFP044-P-1010C

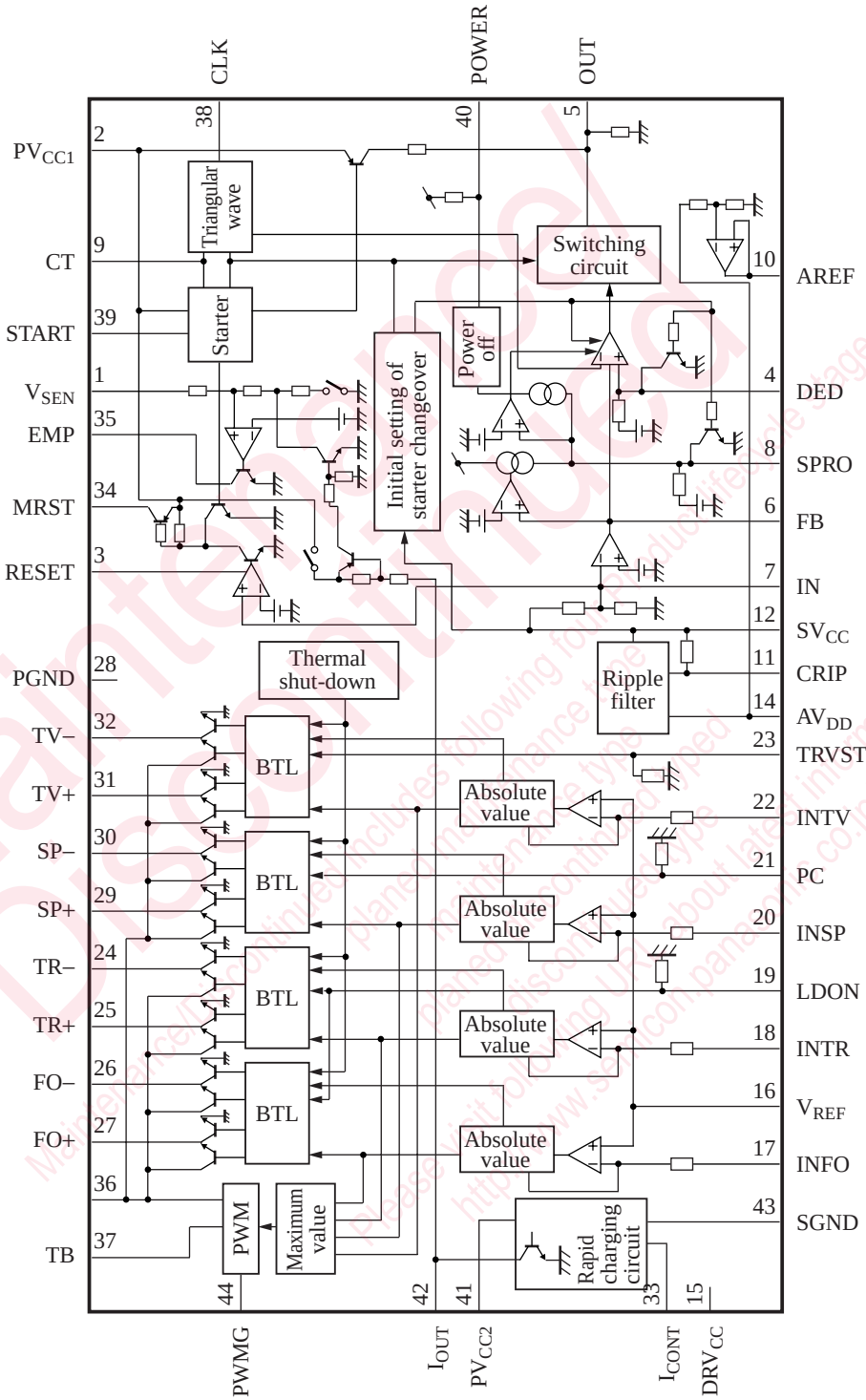
■ Features

- Low power consumption due to PWM control of driver supply by an external circuit.
- Chargeable battery driving is possible due to a built-in rapid charging circuit.
- DC-DC converter can be constructed with an external circuit.
- Rationalization of set design due to a built-in reset circuit with mute and battery voltage detection circuit.
- Ripple filter for D/A converter can be constructed with one external capacitor.
- Thermal shut-down circuit built-in (with hysteresis)

■ Applications

- Portable CD/MD player
- CD/MD player

■ Block Diagram



■ Pin Descriptions

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	V_{SEN}	Empty detection input pin	23	TRVSTOP	Driver on-off control pin
2	PV_{CC1}	Power supply pin	24	TR–	Driver output pin
3	RESET	Reset output pin	25	TR+	Driver output pin
4	DED	Dead time input pin	26	FO–	Driver output pin
5	OUT	DC-DC converter output pin	27	FO+	Driver output pin
6	FB	Error amp. output pin	28	PGND	GND pin
7	IN	Error amp. input pin	29	SP+	Driver output pin
8	SPRO	Short circuit protection input pin	30	SP–	Driver output pin
9	CT	Triangular oscillation pin	31	TV+	Driver output pin
10	AREF	1/2 AV_{DD} output pin	32	TV–	Driver output pin
11	CRIP	Ripple rejection capacitor pin	33	I_{CONT}	Charge current setting pin
12	SV_{CC}	Power supply pin	34	MRST	Muting reset output pin
13	N.C.	—	35	EMP	Empty detection output pin
14	AV_{DD}	Ripple filter output pin	36	V_C	Driver supply voltage pin
15	DRV_{CC}	Power supply pin	37	TB	PWM circuit output pin
16	V_{REF}	1/2 V_{CC} inpiut pin	38	CLK	External sync. input pin
17	INFO	Driver input pin	39	START	Oscillation start input pin
18	INTR	Driver input pin	40	POWER	Power on-off input pin
19	LDON	Driver on-off control pin	41	PV_{CC2}	Power supply pin
20	INSP	Driver input pin	42	I_{OUT}	Charge-cum-battery check pin
21	PC	Driver on-off control pin	43	SGND	GND pin
22	INTV	Driver input pin	44	PWMG	PWM loop gain adjustment pin

■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	PV_{CC1} , PV_{CC2}	14.5	V
	SV_{CC} , DRV_{CC}	6	
Supply voltage range	PV_{CC1} , PV_{CC2}	– 0.3 to +14.5	V
	SV_{CC} , DRV_{CC}	– 0.3 to +6	
V_{SEN} pin max. apply voltage	V_{1max}	14.5	V
Supply current 1	I_{SVCC}	50	mA
Supply current 2	I_{DRVCC}	50	mA
Supply current 3	I_{PVCC1}	100	mA
Supply current 4	I_{PVCC2}	50	mA
Driver output current	I_O	500	mA

Note) 1. Do not apply external currents or voltages to any pins not specifically mentioned.
For circuit currents, '+' denotes currents flowing into the IC, and '–' denotes current flowing out of the IC.

■ Absolute Maximum Ratings (continued)

Parameter	Symbol	Rating	Unit
Power dissipation *1, *2	P_D	490	mW
Operating ambient temperature *1	T_{opr}	−25 to +75	°C
Storage temperature *1	T_{stg}	−55 to +150	°C

Note) 1. Do not apply external currents or voltages to any pins not specifically mentioned.
For circuit currents, '+' denotes currents flowing into the IC, and '−' denotes current flowing out of the IC.
2. ∗1: Except for the operating ambient temperature and storage temperature, all ratings are for T_a = 25°C.
∗2: T_a = 85°C. For the independent IC without a heat sink.
Refer to "■ Application Notes" at mounting on PCB.

■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	PV_{CC1}	1.5 to 14	V
	PV_{CC2}	3 to 14	
	SV_{CC} , DRV_{CC}	2.7 to 5.5	

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Common block						
SV_{CC} power supply current at no load	I_{12Q}	PV_{CC1} = 2.4 V SV_{CC} = DRV_{CC} = 3.2 V, V_{REF} = 1.6 V	—	3	4.5	mA
DRV_{CC} power supply current at no load	I_{15Q}	PV_{CC1} = 2.4 V SV_{CC} = DRV_{CC} = 3.2 V, V_{REF} = 1.6 V	—	2.8	4.2	mA
PV_{CC1} power supply current at no load	I_{2Q}	PV_{CC1} = 2.4 V SV_{CC} = DRV_{CC} = 3.2 V, V_{REF} = 1.6 V	—	1.7	3	mA
PV_{CC1} bias current	I_{2L}	PV_{CC1} = 14 V SV_{CC} = DRV_{CC} = 0 V, V_{REF} = 0 V	—	—	100	µA
At I_{OUT} pin open PV_{CC2} power supply current	I_{41MAX}	PV_{CC1} = 0 V, PV_{CC2} = 5 V SV_{CC} = DRV_{CC} = 0 V, V_{REF} = 0 V I_{CONT} pin short circuit.	11	18	25	mA
DC-DC converter block Error amplifier						
SV_{CC} pin threshold voltage	V_{12TH}	I_{FB} = 0 µA	3.25	3.42	3.59	V
FB pin output voltage (source current)	V_{6+}	IN = 0.8 V, I_{FB} = −100 µA	1.6	1.8	2	V
FB pin output voltage (sink current) *	V_{6-}	IN = 1.5 V, I_{FB} = 100 µA	—	—	0.25	V

Note) ∗: Output voltage OUT be kept at low-level in measuring an output voltage (sink current) of FB pin.

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Short circuit protection circuit						
SPRO pin bias voltage	V_{8B}	V_{IN} = 1.5 V, POWER = high	0.77	0.86	0.94	V
SPRO pin impedance	R_8	V_{IN} = 1.5 V	22	32	45	kΩ
SPRO pin output voltage (at FB = high)	V_{8FB}	POWER = high, V_{IN} = 0.8 V	1.3	1.8	2.3	V
SPRO pin output voltage (at POWER = low)	V_{8PO}	POWER = low, V_{IN} = 1.5 V	1.9	2.5	3	V
SPRO pin threshold voltage	V_{8TH}	V_{CT} = 0.2 V, V_{IN} = 1.5 V	1.03	1.11	1.2	V
Output block						
High-level voltage at OUT pin in self running	V_{5H}	V_{CT} = 0 V, I_{OUT} = −10 mA V_{FB} = 0.7 V	1.08	1.5	1.71	V
Low-level voltage at OUT pin in self running	V_{5L}	V_{CT} = 1.0 V, I_{OUT} = +10 mA V_{FB} = 0.5 V	0.15	0.3	0.4	V
High-level at OUT pin at starting	V_{5HS}	V_{CT} = 1.0 V, PV_{CC1} = 1.5 V I_{OUT} = −1.1 mA, SV_{CC} = 0 V	0.7	0.92	1.3	V
Pulse max. duty at OUT pin at starting	D_{5S}	PV_{CC1} = 5.0 V, SV_{CC} = 0.0 V	53	64	75	%
Pulse max. duty at OUT pin in CLK sync.	D_{5C}	V_{IN} = 0.8 V	65	75	85	%
Pulse max. duty at OUT pin in self running	D_{5F}	V_{IN} = 0.8 V	75	81	87	%
Triangular oscillation frequency at CT pin in self running	f_{9F}		53	64	75	kHz
Triangular oscillation frequency at CT pin at starting	f_{9S}	PV_{CC1} = 5 V, SV_{CC} = 0 V	70	90	100	kHz
Output current at CT pin in self running (source current)	I_{O-F}	V_{CT} = 0.3 V	42	60	82	µA
Output current ratio at CT pin in self running (source current/sink current)	I_{O+}/I_{O-} (RFEE)	V_{CT} = 1 V	1.25	1.55	2.00	—
Triangular wave oscillating PV_{CC1} voltage	V_{2MIN}	SV_{CC} = 0 V	1.5	—	—	V
Dead time pin block						
DED pin impedance	R_4	V_{IN} = 1.5 V, V_{POWER} = 3 V V_{START} = 3 V	40	60	80	kΩ
DED pin bias voltage	V_{4B}	V_{IN} = 1.5 V, V_{POWER} = 3 V V_{START} = 3 V	0.72	0.8	0.92	V

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
POWER pin block						
POWER pin high-level input threshold voltage	V_{40THH}	V_{IN} = 1.5 V, I_{DED} = 0 µA V_{START} = 3 V	2	—	—	V
POWER pin low-level input threshold voltage	V_{40THL}	V_{IN} = 1.5 V, I_{DED} = 0 µA V_{START} = 3 V	—	—	0.8	V
START pin block						
START pin bias voltage	I_{39B}	V_{START} = 0 V, SV_{CC} = DRV_{CC} = 0 V PV_{CC1} = 2.4 V	17	29	41	µA
START pin input threshold voltage	V_{39TH}	V_{CT} = 1 V, SV_{CC} = DRV_{CC} = 0 V	1.4	1.7	2.0	V
CLK pin block						
CLK pin input threshold VTHH	V_{38THH}	f_{IN} = 88.2 kHz	2.0	—	—	V
CLK pin input threshold VTHL	V_{38THL}	f_{IN} = 88.2 kHz	—	—	0.8	V
Empty detection block						
EMP pin detection voltage (dry battery)	V_{35TH1}	I_{IOUT} = −2 µA	1.7	1.8	1.9	V
EMP pin detection voltage (rechargeable battery)	V_{35TH3}	V_{IOUT} = 0 V	2.1	2.22	2.3	V
EMP pin hysteresis width from empty detection to recovery (dry battery)	V_{35H}	I_{IOUT} = −2 µA	30	60	82	mV
EMP pin hysteresis width from empty detection to recovery (rechargeable battery)	V_{35L}	V_{IOUT} = 0 V	30	60	82	mV
EMP pin output voltage	V_{35O}	I_C = +1.0 mA, V_{SEN} = 1 V	—	—	0.5	V
EMP pin output leak current	I_{35L}	V_{EMP} = 3.2 V, V_{SEN} = 3.0 V	—	—	1.0	µA
V_{SEN} pin input resistance	R_1	V_{IOUT} = 0 V	16.5	20.8	25.0	kΩ
V_{SEN} pin input leak current	I_{1L}	SV_{CC} = 0 V, V_{SEN} = 4.5 V	—	—	1	µA
I_{OUT} pin low-level detection voltage	V_{42THL}	V_{1THL} = PV_{CC1} − V_{42}	1.5	—	—	V
Allowable leak current at I_{OUT} pin "Hi-Z"	I_{42THH}	Must be Hi-Z mode when I_{OUT} pin output current is −2 µA	−2.0	—	—	µA
RESET output block						
SV_{CC} pin reset threshold voltage ratio	H_{12}	$\frac{\text{Reset threshold voltage}}{\text{Error amp. threshold voltage}}$	0.85	0.9	0.95	—
RESET pin low-level output voltage	V_{RL}	I_{RESET} = +1.0 mA	—	—	0.5	V
RESET pin output impedance	V_{RH}	I_{RESET} = 0 mA	55	83	110	kΩ
MRST pin output voltage (at reset, at starter)	V_{340}	I_{MRST} = −1.0 mA, V_{START} = SV_{CC} = 0 V	1.8	—	2.4	V
MRST pin output leak current	I_{34L}	V_{MRST} = 0 V	−1.0	—	—	µA

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Start to normal changeover						
SV_{CC} pin starter changeover voltage at starting → at self running	V_{12TH1}		2.3	2.5	2.7	V
SV_{CC} pin starter changeover voltage at self running → at starting	V_{12TH2}		2.1	2.3	2.5	V
SV_{CC} pin starter changeover voltage hysteresis width	V_{12TH}		0.12	0.18	0.24	V
Initial setting						
SV_{CC} pin initial setting release voltage	V_{12DK}		1.6	1.8	2.0	V
Ripple filter block						
AV_{DD} pin potential difference between SV_{CC} and AV_{DD}	V_{14}	I_{AVDD} = −5 mA CRIP = open	0.24	0.28	0.32	V
AV_{DD} pin saturation voltage	V_{14SAT}	I_{AVDD} = −5 mA, V_{CRIP} = SV_{CC}	—	—	0.15	V
CRIP pin input resistance	R_{11}	SV_{CC} = 0 V, I_{CRIP} = 25 µA	9.0	12.5	16.0	kΩ
AV_{DD} pin ripple rejection factor	RR_{14}	V_{IN} = 35 mV_{RMS} , f_{IN} = 20 kHz	40	—	—	dB
1/2 AV_{DD} circuit						
AREF pin output voltage	V_{AREF}	I_{AREF} = 0 mA, V_{AREF} = AV_{DD} −2V_{AREF}	−100	0	100	mV
AREF pin output impedance 1	ΔV_{AREF1}	I_{AREF} = +400 µA	560	800	1 040	mV
AREF pin output impedance 2	ΔV_{AREF2}	I_{AREF} = −100 µA	−140	−200	−260	mV
AREF pin discharge current at RESET	I_{ARST}	SV_{CC} = AV_{DD} = 1.0 V V_{AREF} = 1.0 V, V_{REF} = 0	1.4	2.0	2.6	mA
Charging current						
I_{CONT} pin voltage	V_{ICONT}	PV_{CC2} = 4.5 V, I_{CONT} = 0.05 mA	1.1	1.2	1.3	V
I_{OUT} current	I_{OUT}	PV_{CC2} = 4.5 V, V_{IOUT} = 1.0 V I_{CONT} = 0.7 mA	200	265	350	mA
I_{OUT} leak current	I_{OLEAK}	PV_{CC2} = 4.5 V, SV_{CC} = 0 V PV_{CC1} = V_{IOUT} = 14 V I_{CONT} pin open	—	—	2	µA
PWM comp.						
PWMG amp. transfer gain	G_{PWM}	V_{REF} = 1.6 V, V_{INFO} = 1.4 V	1/6.0	1/7.2	1/8.5	1/kΩ
TB pin sink current ability	I_{TB}	V_{INFO} = 2.1 V	9	10	15	mA
V_C level shift	V_C	V_{INFO} = 1.7 V	0.35	0.45	0.55	V
V_C leak current	I_{VCL}	V_C = 9 V	—	—	8	µA
Over voltage protection circuit detection voltage (V_{SEN} pin)	V_{SENOFF}		8.0	8.4	9.0	V

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Driver block						
(Focus) transfer gain (+)	G_{F+}		12	14	16	dB
Transfer gain relative ratio (+/–)	G_+/G_-		–2	0	2	dB
INFO pin dead zone in reference to input	IDZFO		–10	—	10	mV
INFO pin input internal resistance	R_{16}		9	11	13	kΩ
Output offset voltage	V_{FOFF} (OUT)		–50	—	50	mV
Saturation voltage (lower side tr.)	V_{FSATL}	I_D = 300 mA, LDON = 3.0 V	—	0.3	0.5	V
Saturation voltage (upper side tr.)	V_{FSATU}	I_D = 300 mA, LDON = 3.0 V	—	0.4	0.6	V
FO+ pin max. drive voltage	V_{F+}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INFO = 2.5 V	—	—	1.2	V
FO– pin max. drive voltage	V_{F-}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INFO = 0.7 V	—	—	1.2	V
LDON pin high-level threshold voltage	V_{TH18H}	V_{REF} = 1.6 V, INFO = 1.8 V	2.0	—	—	V
LDON pin low-level threshold voltage	V_{TH18L}	V_{REF} = 1.6 V, INFO = 1.8 V	—	—	1.0	V
V_{REF} pin driver on-off high-level threshold voltage	V_{TH15H}	INFO = 1.8 V	1.25	—	—	V
V_{REF} pin driver on-off low-level threshold voltage	V_{TH15L}	INFO = 1.8 V	—	—	0.75	V
(Tracking) transfer gain (+)	$G_{TR(+)}$		12	14	16	dB
Transfer gain relative ratio (+/–)	G_+/G_-		–2	0	2	dB
INTR pin dead zone in reference to input	IDZTR		–10	—	10	mV
INTR pin input internal resistance	R_{17}		9	11	13	kΩ
Output offset voltage	V_{TROFF} (OUT)		–50	—	50	mV
Saturation voltage (lower side tr.)	V_{TRSATL}	I_D = 300 mA, LDON = 3.0 V	—	0.3	0.5	V
Saturation voltage (upper side tr.)	V_{TRSATU}	I_D = 300 mA, LDON = 3.0 V	—	0.4	0.6	V
TR+ pin max. drive voltage	V_{TR+}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INTR = 2.5 V	—	—	1.2	V
TR– pin max. drive voltage	V_{TR-}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INTR = 0.7 V	—	—	1.2	V
(Spindle) transfer gain (+)	$G_{SP(+)}$		21.5	23.5	24.5	dB
Transfer gain relative ratio (+/–)	G_+/G_-		–2	0	2	dB
INSP pin dead zone in reference to input	IDZSP		–10	—	10	mV
INSP pin input internal resistance	R_{19}		6	7.5	9	kΩ

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Driver block (continued)						
Output offset voltage	V_{SPOFF} (OUT)		–100	—	100	mV
Saturation voltage (lower side tr.)	V_{SPSATL}	I_D = 300 mA, LDON = 3.0 V	—	0.3	0.5	V
Saturation voltage (upper side tr.)	V_{SPSATU}	I_D = 300 mA, LDON = 3.0 V	—	0.4	0.6	V
SP+ pin max. drive voltage	V_{SP+}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INSP = 2.0 V	—	—	1.2	V
SP– pin max. drive voltage	$V_{SP–}$	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INSP = 1.2 V	—	—	1.2	V
PC pin high-level threshold voltage	V_{TH20H}	V_{REF} = 1.6 V, INSP = 1.7 V	2.0	—	—	V
PC pin low-level threshold voltage	V_{TH20L}	V_{REF} = 1.6 V, INSP = 1.7 V	—	—	1.0	V
(Traverse) transfer gain (+)	$G_{TV(+)}$		12	14	16	dB
Transfer gain relative ratio (+/–)	$G_+/G_–$		–2	0	2	dB
INTV pin dead zone in reference to input	IDZTV		–10	—	10	mV
INTV pin input internal resistance	R_{21}		9	11	13	kΩ
Output offset voltage	V_{TVOFF} (OUT)		–50	—	50	mV
Saturation voltage (lower side tr.)	V_{TVSATL}	I_D = 300 mA, LDON = 3.0 V	—	0.3	0.5	V
Saturation voltage (upper side tr.)	V_{TVSATU}	I_D = 300 mA, LDON = 3.0 V	—	0.4	0.6	V
TV+ pin max. drive voltage	V_{TV+}	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INSP = 2.0 V	—	—	1.2	V
TV– pin max. drive voltage	$V_{TV–}$	PV_{CC1} = 4.0 V, SV_{CC} = 3.2 V INSP = 1.2 V	—	—	1.2	V
TRVSTOP pin Threshold voltage (high-level)	V_{TH22H}		2.0	—	—	V
TRVSTOP pin Threshold voltage (low-level)	V_{TH22L}		—	—	1.0	V
TRVSTOP pin Brake current at high-level	I_{22}		5	8	12	mA

■ Electrical Characteristics at SV_{CC} = DRV_{CC} = 3.2 V, PV_{CC1} = 2.4 V, PV_{CC2} = 0 V, T_a = 25°C (continued)

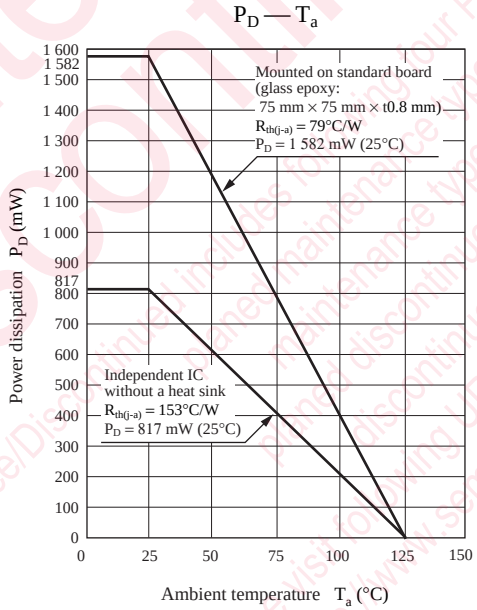
• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

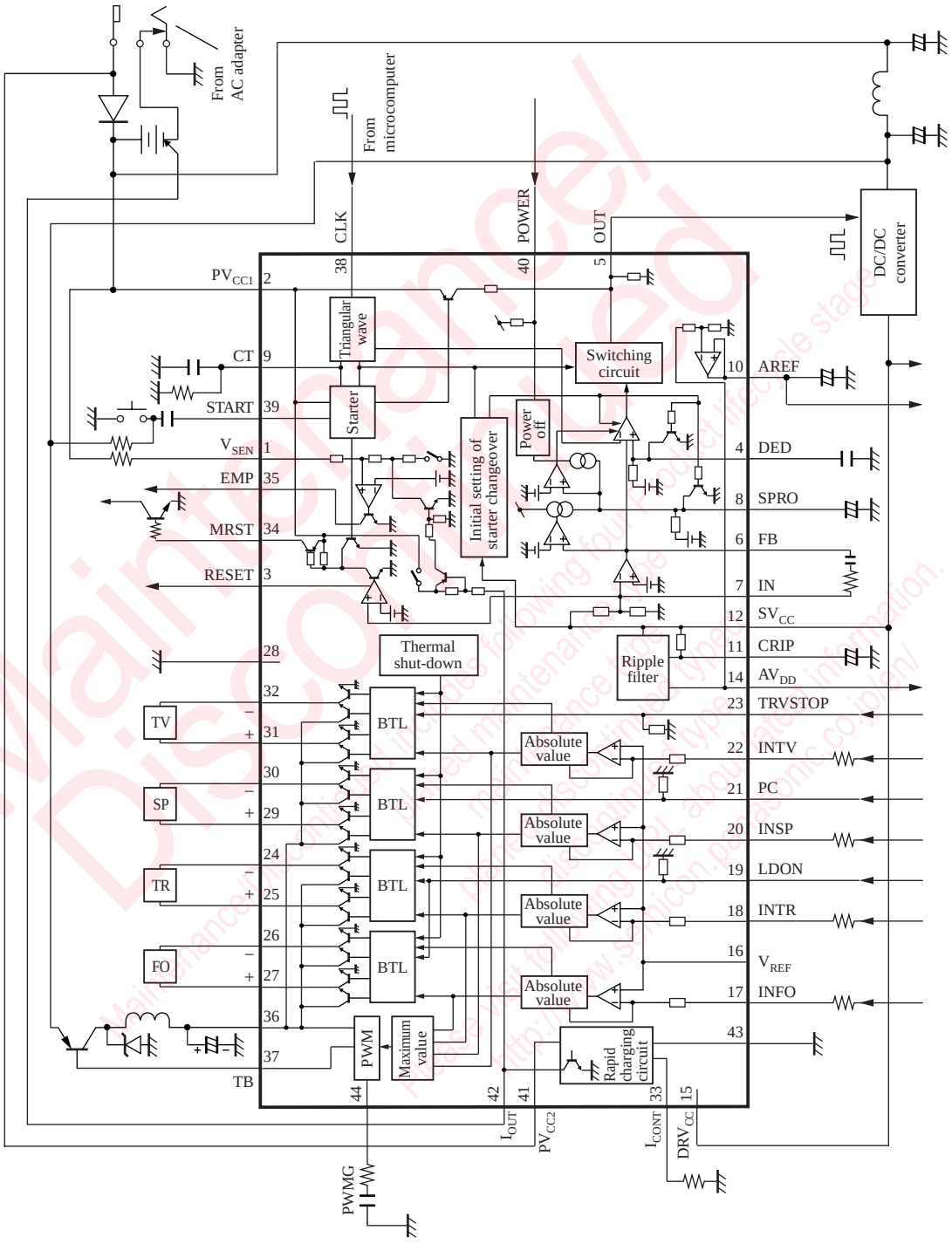
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Thermal shutdown operating temperature Driver: Operation → stop	T_{ON}		—	150	—	°C
Thermal shutdown operating temperature hysteresis width	DT		—	30	—	°C
Min. output pulse width in sync., at OUT pin	PT_{min}		—	0.7	—	µs
AV_{DD} pin output noise	RR_{13}		—	—	10	µV[rms]
Charge circuit thermal shutdown operation temperature	TC.ON		—	150	—	°C

■ Application Notes

• P_D — T_a curves of QFP044-P-1010C



■ Application Circuit Example



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